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# THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF THE FLESH OF BALEEN WHALE

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The flesh from the dorsal and ventral sections of the body of Baleen /65
whale, mainly fin whale and sei whale, is prepared for nutritional purposes. The carcass of a fin whale averaging 27 tons in weight consists of 16.5 tons of flesh, and that of a sei whale averaging 26 tons - approximately 14.4 tons. The average relative weight of flesh (in percentage of carcass weight) for the fin whale is 35% (dorsal, 20%, and ventral, 15%), and for the sei whale, 40% (dorsal, 23%, and ventral, 17%); with optimal whale dressing under commercial conditions, the average yield of flesh for nutritional purposes for fin whale may be 25%, that is approximately 12 tons, and for sei whale, 30% or 8 tons.

Our studies of the chemical composition of the flesh of whales, particularly the determination of its amino-acid, vitamin and trace-element content, and a comparison of the resulting data with the data available in the literature on the composition of the meat of domestic animals (cattle, hogs, sheep), indicated that the flesh of whales contains more protein and slightly less fat (Table 1).

The chemical composition of the dorsal and ventral flesh of whales differs somewhat in collagen content. There is less collagen in the dorsal flesh than in the ventral flesh: 2.9-3.9% (which corresponds to its quantity in beef) as against 3.3-6.3% (when converted to raw matter).

Compared with the meat of domestic farm animals, the meat of whales is large-fibred, with inclusions of connective tissue, which give it a coarser texture. It also has a rather distinctive aroma. The colour of whale meat, which is governed by the presence of pigments and myoglobin, depends on the species and age, and also on the physiological state of the animal before slaughter. The meat of young whales,

like that of veal, has a slightly reddish tinge, and the meat of the adult animals is bright red, resembling beef. The colour of whale meat is also affected by the extent to which the carcass is bled, the pH, and the glycogen content of the muscle tissue.

Whale meat differs from the meat of domestic animals (beef, mutton) in having a greater content of essential amino acids: histidine - 3-4 times more, methionine and tryptophan - 1.5-2 times more, sulphur-containing amino acids (cistine + cystein) - 2-3 times more (in percentage of raw matter, Table 2).

The biological value of meat products is determined on the basis of the quality index, which represents the ratio between the content of the essential amino acid tryptophan, which is included only in complete proteins, and oxyproline, which is a permanent component of the proteins of the connective tissue. the quality index for fin-whale meat is 5.2-6.3 and for sei whale, 5.7-7.0, whereas for beef of average condition it is only 4.8 (according to Solntseva, 1967).

Of the total amount of nitrogenous substances in the frozen meat of baleen whales comprising on average 3.5% of the weight of raw matter, proteins account for 77-86%. The average content of non-protein nitrogenous substances is 18.5-20.2%, and that of free amino acids is approximately 4% of the total content of nitrogenous substances of whale meat. In beef, the content of non-protein nitrogenous substances if considerably lower. In the dorsal and fillet portions of the carcass, it ranges from 11.0 to 12.5% of the total nitrogen of the meat, and in the breast and flank - from 8.8 to 11.8%. In mutton, in the shoulder portion, the percentages are 10.2-13.7%, and in the breast and flank, 8.0-14.6% (based on Pal'min et al., 1953). /66

Whale meat, in contrast to beef, contains 3-4 times more extractive matter - carnosine and anserine. It also differs in having a slightly higher content of creatine, 0.43-0.50% as opposed to 0.4% in beef. But, purine and hypoxatine in whale meat comprises roughly 0.12%, which corresponds to their content in the meat of domestic animals. Whale meat contains small amounts of mono-, di- and tri-methylamines (0.01-0.02% of the total content of nitrogenous substances), which are inherent in the muscular tissue of fish and which determine the distinctive aroma of whales (according to the data of Sharp and Marsh, 1953).

The mineral composition of whale meat and the meat of domestic animals (the latter, according to the data of Krylova and Lyaskovska, 1968; Krylova and Balabukh 1970), determined by the method of emission spectral analysis, is presented in Table 3 (in mg percentages of the raw product).

Of the total amount of phosphorus in sei-whale meat, non-organic phosphorus accounts for 62-69%, and phosphorus which is part of the organic compounds (phospho-

Table 1

| Meat | Chemical composition, % | | | | Caloricity Kcal/100 g of meat |
|---|---|---|---|---|---|
| | moisture | fat | protein | mineral matter | |
| Sei whale | | | | | |
| dorsal | 73,4±2,10 | 3,3±1,58 | 22,4±2,05 | 1,0±0,12 | 122,7±16,2 |
| ventral | 73,1±3,16 | 2,9±2,32 | 23,2±2,26 | 1,0±0,10 | 121,0±22,4 |
| Fin whale | | | | | |
| dorsal | 74,2±1,20 | 2,3±1,32 | 22,2±1,28 | 1,0±0,10 | 112,4±16,1 |
| ventral | 72,7±2,40 | 4,2±2,39 | 22,0±0,82 | 1,5±0,05 | 129,2±25,9 |
| Beef | | | | | |
| data of Mikhailova, Finogenova (1963) | 75,86±0,76 | 2,17±1,26 | 18,9±0,86 | 0,95±0,07 | 95,5±6,4 |
| data of Pavlovski, Pal'min (1963) | 55,0—69,0 | 11,0—28,0 | 16,2—19,4 | 1,0—1,3 | 180,0—320,0 |
| Mutton data of Pavlovski and Pal'min (1963) | 72,5—77,0 | 3,0—6,5 | 20,0—21,0 | 0,9—1,0 | 114,0—142,4 |

Table 2

| Aminoacids | Dorsal meat of whales | | Meat of farm animals | |
|---|---|---|---|---|
| | Sei whale | Fin whale | Beef (data of Krylova, Lyaskovskaya, 1968, Mitsyku et al., 1973) | Mutton, on average (data of Krylova, Lyaskovskaya, 1968) |
| Lysine | 1,16—1,24 | 1,07—2,26 | 1,62—1,68 | 1,52 |
| Leucine + isoleucine | 2,07—2,67 | 2,01—3,95 | 2,59—2,81 | 2,48 |
| Methionine | 0,63—1,91 | 0,45—0,86 | 0,42—0,48 | 0,46 |
| Tryptophan | 0,36—0,40 | 0,21—0,28 | 0,22—0,27 | 0,26 |
| Valine + phenylalanine | 0,59—1,51 | 0,93—1,72 | 1,94—2,02 | 1,86 |
| Threonine + Glutamic acid | 3,66—4,22 | 2,29—7,29 | 2,97—3,79 | 3,86 |
| Arginine | 0,70—2,85 | 0,53—1,70 | 1,32—1,37 | 1,38 |
| Histidine | 0,99—2,06 | 1,28—3,07 | 0,58—0,60 | 0,54 |
| Alanine | 1,10—1,20 | 0,96—1,46 | 1,00—1,22 | — |
| Glycin | 0,66—0,73 | 0,37—1,24 | 1,09—1,35 | — |
| Tyrosine | 0,63—0,94 | 0,27—1,43 | 0,64—0,81 | 0,64 |
| Cystine + cysteine | 0,61—1,12 | 0,36—1,08 | 0,28—0,40 | 0,26 |
| Serine + Aspartic acid | 2,30—2,35 | 1,24—4,85 | 1,90—2,40 | — |

*Determinations for whale meat based on paper chromatography

Table 3

| Elements | Dorsal meat | | Beef | Pork | Mutton |
|---|---|---|---|---|---|
| | Fin whale | Sei whale | | | |
| **Macroelements** | | | | | |
| Phosphorus | 164–216 | 130–148 | 130 - 210 | 157–168 | 138–213 |
| Potassium | 149–341 | 235–326 | 338 | 300 | Not determined |
| Magnesium | 20–23 | 25–51 | 17–24 | 24 | |
| Calcium | 15 | 13 | 8–12 | 8–12 | 9 -10 |
| Iron | 1,4–3,1 | 1,8–2,3 | 1,8–3,0 | 2,2–2,5 | 2,2 -2,7 |
| **Microelements** | | | | | |
| Copper | 0,003–0,020 | 0.003–0,020 | 0,035–0,063 | 0,027–0,033 | 0,081–0,095 |
| Manganese | 0–0,040 | traces–0,190 | 0,009–0,023 | 0,010–0,011 | 0,026–0,028 |
| Cobalt | 0,058–0,080 | 0,065–0,073 | 0,004–0,035 | 0,004–0,005 | 0,003–0,004 |
| Zinc | traces– 1,100 | 1,400–1,900 | 2,590–4,400 | 1,360–1,450 | 3,000–3,470 |
| Aluminum | 0,001–0,090 | 0,001–0,070 | Not determined | | |
| Tin | 0,036–0,052 | 0–0,066 | Not determined | 0,003–0,004 | 0,003–0,004 |

Table 4

| Meat | Vitamins, mg% of raw product | | | |
|---|---|---|---|---|
| | $B_1$ | $B_2$ | PP | C |
| Fin whale | 0,04–0,05 | 0,25–0,40 | 4,7–5,7 | 2,16–2,2 |
| Beef | 0,03–0,10 | 0,13–0,17 | 3,9–6,7 | 0–5,0 |
| Mutton | 0,13–0,16 | 0,18–0,22 | 4,3–5,2 | – |
| Sei whale | 0,74–0,94 | 0,18–0,19 | 3,9–4,3 | – |

lipids, ATP, ADF, AMP*, creatine phosphate, phosphoproteins etc.) accounts for 31-38%. In fin-whale meat, non-organic phosphorus comprises 45-54% and organic phosphorus, 46-55%.

Whale meat greatly surpasses the meat of domestic animals in cobalt, manganese and tin content. It is a particularly important source of cobalt, the biological role /67 of which is generally well known.

The value of whale meat as a source of nourishment is indicated by the data presented in Table 4 (based on the data of Novikova, 1950, 1953; Marchuk, 1964; Pavlovskii and Pal'mina, 1963).

The distinctive feature of whale meat is its marked reduction in volume when defrosted and the considerable separation of juice (up to 20-30% of the total weight of the meat). This is not a sign of poor-quality meat, and can be explained by the fact that whale meat is frozen prior to or at the onset of rigor mortis. With freezing and defrosting, glycogen decomposes. Whale meat contains a large amount of glycogen (830-10,000 mg% in steamed meat and up to 525-650 mg% in frozen meat 4-5 months after being stored at -16 to -18°C).

As a result of the formation of lactic acid from the glycogen, the pH of whale meat drops to 5.4-5.7, which corresponds to the pH level of the meat of domestic animals in the period of rigor mortis (Solov'ev, 1966). In this same period, proteins have minimal hydrophilic capacity. This feature of whale meat must be taken into consideration during processing.

The data presented testify to the high caloricity and nutritive value of sei-whale and fin-whale meat. Whale meat is a source of all essential amino acids, and a source of vitamins and trace elements. It can be used with great success for protein nutrition and for establishing balanced rations in terms of amino acids and microelements in accordance with the physiological standards of human nutrition.

In view of its specific qualities, steamed whale meat requires more thorough primary processing - complete removal of fatty and connective tissues, good bleeding and lengthy rinsing. To improve the texture of the frozen meat it is advisable to treat it with enzyme preparations. Very valuable natural products can be prepared from whale meat - products such as canned goods, sausages, various cooking products, as well as meat protein extracts or high-calorie concentrates, such as dry nutritive flour and nutritive protein.

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*ATP - adenosine triphosphate; ADF - adenosine diphosphate; AMP - adenosine monophosphate.